LEG TERATOLOGY IN *GALERUCELLA SAGITTARIAE* (GYLLENHAL) (COL.: CHRYSOMELIDAE)

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BILATERAL SYMMETRY is one of the most basic rules governing the structure, growth and development of insects. Departures from it, as in the case of bilateral gynandromorphs and chimeras in the Lepidoptera, are highly prized by collectors and valued as perhaps giving some insights into developmental and embryological processes.

Teratological specimens in orders other than the Lepidoptera are not common, but do occur; their apparent rarity is probably due to the fact that they are difficult to spot in the field and are usually only noticed when specimens are mounted or later examined for identification. Usually a single specimen shows a unique malformation.

However, I recently came across two almost identical terratological specimens of the leaf beetle *Galerucella sagittariae* (Gyllenhal) together in the same locality.

Occurrence

On a visit to Powdermill Reservoir near Brede, East Sussex, on 23rd August 1994, I discovered that what was once open water in the north-westerly third of the lake was now standing high and moderately dry. The reservoir is owned and managed by South-East Water and the reduction of water levels by about six feet had left mud flats exposed for some weeks or months. These flats were now covered in a sea of amphibious bistort, *Polygonum amphibium* L.

The bistort stood knee-high and was being devoured by countless millions of the larvae of *Galerucella sagittariae*. The adults too were present in uncountable numbers and I took a sample of eight specimens from a single sweep of the net. It was not until these were set later that evening that the unusual teratology was noticed.

Description

Two of the eight specimens had severely stunted right middle legs (Figs 1, 2b & 2c). The remaining five legs and the antennae of each specimen appeared to be normal. Detailed examination showed that in both aberrant specimens the stunted legs were shorter and slighter. In the two specimens the right femora were reduced to, respectively, 77 and 60% of the left, the right tibiae to (both) 60% of the left and the right tarsi to 40 and 48% of the left. The deformed tarsi were severely shortened and misshapen (Figs. 2b & 2c). Table 1 gives body and limb measurements of the two aberrant specimens compared to the six "normal" specimens. Only the affected middle right legs showed a significant size discrepancy being well outside

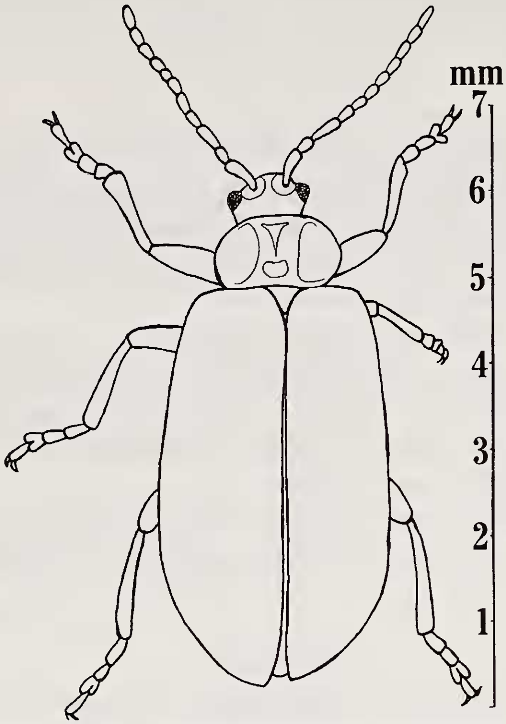

Fig. 1. Aberrant specimen (1) of *Galerucella sagittariae*, showing gross reduction in right leg size.

the "normal" range. Aberrant specimen 1 was slightly shorter than all the other specimens.

My father, Mr A.W. Jones was also present with me at Powdermill Reservoir that day and had also taken a number of specimens of the *Galerucella*. Examination of 11 of these showed that they all appeared normal. Detailed leg measurements of these specimens are not given, but they all fell within or close to the same "normal" range.

Discussion

Bilateral gynandromorphs and sexual mosaics or chimeras are uncommon, but because they are so distinctive in some Lepidoptera, they are moderately frequently captured and identified. Their occurrence is thought to be due to loss of the male Y chromosome early on in embyological cell division and development leaving some cells of the growing insect with XY genotype, hence male phenotype,and others with XO genotype which by default exhibits the female phenotype (Ford, 1945).

Teratological specimens of other orders are also not common, but they do occur. They are usually only noticed upon detailed examination long after capture and so their apparent rarity is compounded (Jones, 1989, Hancock, 1992).

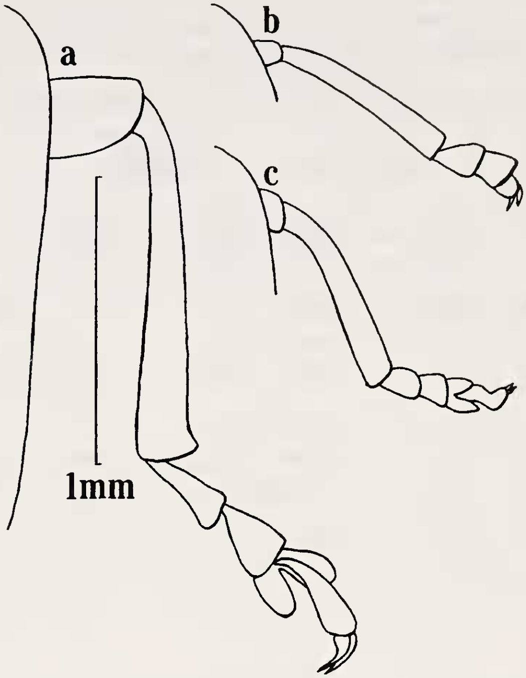

Fig. 2. Middle right legs of *Galerucella sagittariae*: a. normal specimen; b. aberrant specimen 1; c. aberrant specimen 2. All legs are in dorsal view and drawn to same scale.

A delightful and curious book by Mocquerys (1880) gives brief descriptions and small woodblock figures of numerous beetle "monsters" Many of these are malformations of the legs. Each is a unique specimen and apart from vague comments on interrupted development or embryological breakdown, no detailed explanation is offered for their appearance.

A model of leg development was propounded by French, Bryant & Bryant (1976) to explain supernumerary and other forms of growth produced during regeneration after surgery to amphibian limbs. Many of the "monsters" illustrated by Mocquerys (1880) show similar supernumerary digitation and it is tempting to suggest that the development of such aberrant limbs was brought about because of damage during ecdysis or metamorphosis. In the case of two almost identical deformations in the leaf beetles discussed here it would seem unlikely that two insects could suffer identical injuries to identical middle right legs.

In insects, adult structures such as wings and legs, are represented in the larval stage as groups of cells called imaginal discs (eg Gullan & Cranston, 1994, and other textbooks). These discs are analogous to buds. During metamorphosis they are pushed through to the outside of the body and change shape by cell reproduction, differentiation and movement. The underlying causes of these changes are not precisely known (Bard, 1990), but the development of *Drosphila* fruit fly leg discs from buds to limbs has been visualised using scanning electron microscopy (Fristrom, 1976, 1988).

Table 1. Body and limb measurements (in millimetres) of six normal and two aberrant specimens of *Galerucella sagittariae* collected together from Powdermill Reservoir, 23rd August 1994.

Measure (ventral)		Aberrant specimen 1		Aberrant specimen 2		Measures of six "normal" specimens (n = 12) mean (range)
		Left	Right	Left	Right	
Front	femora	0.99	0.99	1.09	1.13	1.10 (1.02–1.19)
	tibiae	1.02	1.02	1.19	1.19	1.06 (0.95–1.19)
	tarsi	0.75	0.78	0.82	0.75	0.79 (0.68–0.89)
Middle	femora	1.19	0.92*	1.30	0.78*	1.26 (1.19–1.36)
	tibiae	1.19	0.72*	1.30	0.78*	1.26 (1.13–1.36)
	tarsi	0.85	0.34*	0.85	0.41*	0.87 (0.78–0.95)
Hind	femora	1.33	1.36	1.36	1.43	1.38 (1.23–1.43)
	tibiae	1.36	1.36	1.43	1.47	1.41 (1.26–1.47)
	tarsi	0.82	0.82	0.85	0.85	0.87 (0.78–0.99)
Antennae		2.73	2.73	2.73	2.73	2.82 (2.73–2.90)
Body length (dorsal)		5.53*		6.33		6.21 (5.88–6.55) (n =6)

Measurements were made using a Meiji SKC-1 microscope and an eye-piece graticule (line divided into 100). Limb lengths were ventral, at x 30 magnification (29.333 units/mm).
Body lengths were dorsal, at x 10 magnification (8.85 units/mm).
*Measurement outside of the "normal" range.

The imaginal disc forms a series of folds representing the various limb segments; it then extents telescopically, transforming into a leg.

Morphological changes during growth and any underlying genetic controls have traditionally been studied apart, since it is still not known how the subcellular and biochemical changes wrought by the genes bring about the gross structural alterations during development. Nevertheless, it is well known that shape, size and form are inherited characteristics.

Drosophila also provides the best studied genetic model for limb development in insects, and during many years of genetic and mutational experimentation various bizarre genes have been discovered or engineered. Several control the embryological development of the various body appendages – antennae, wings and legs. Mutants have often been created and genetically verified in which the two antennae are replaced with seventh and eight legs or the wings multiplied from two to four! I do not know whether left or right-legged characters have been identified in the *Drosophila* genome.

Galerucella sagittariae is gregarious as a larva. After hatching from the batch of five to ten eggs, the larvae move in concert up the leaf, nibbling away the upper surface until as later instars they feed individually, skeletonising the leaves they attack. Since the two aberrant specimens were taken in the same sweep of the net, it is tempting to suggest that they were siblings and that the stunted legs were the result of a naturally occurring mutant gene in the population. However, though one abnormal specimen was of normal size, the other was slightly shorter than normal (Table 1), hence perhaps nutritional factors are also somehow involved.

Butterfly and moth aberrations are usually obvious enough to be spotted while the insects are alive, offering at least some possibility of studying their genetics. Unfortunately, as is too often the case, the oddity of these two beetles was not spotted until it was too late to consider such a course of action.

Acknowledgements

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